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A STRATA MECHANICS INVESTIGATION TO EVALUATE PNEUMATIC STOWING TRIALS AT LINGAN COLLIERY, CAPE BRETON, N.S.

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A STRATA MECHANICS INVESTIGATION TO EVALUATE PNEUMATIC STOWING TRIALS AT LINGAN COLLIERY, CAPE BRETON, N.S.

by

Peter Cain*

SUMMARY

The design of a comprehensive investigation aimed at evaluating the performance of pneumatically stowed gateside packs is outlined, and the major aspects of the investigation are described. Most emphasis is placed on the design of gateroad instrumentation installations. In addition, the need for geotechnical assessment of each site, back analysis of roadway convergence trends and computer modelling of pneumatically stowed gaterroads is discussed with particular reference to the investigation location.

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UNE ENQUÊTE SUR LA MÉCANIQUE DES STRATES, POUR ÉVALEUR LES ESSAIS DE REMBLAYAGE PNEUMATIQUE À LA HOUILLÈRE LINGAN, CAP-BRETON, N.É.

par

Peter Cain*

SOMMAIRE

On décrit ici la conception d'une enquête globale visant à évaleur la performance des parois des voies de roulage, remblayées pneumatiquement; on fait aussi état des principaux aspects de l'enquête. On met surtout l'accent sur la conception des installations d'instrumentation par voie de roulage. De plus, on traite des besoins d'évaluation géotechnique de chaque site, d'analyses antérieures sur la direction de convergence des voies, ainsi que de la modélisation mathématique de voies de roulage remblayées, en se référant particulièrement au lieu de l'enquête.

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INTRODUCTION

The installation of two low pressure pneumatic stowing systems for gateside packs on a trial basis at Cape Breton Development Corporation (CBDC) Lingan Colliery represents a significant attempt to improve mining conditions and costs. As well as direct contributions to safety and production, pneumatic stowing systems demonstrate important indirect benefits associated with tie increased roadway stability which results from their use.

In consultation with CBDC, the Cape Breton Coal Research Laboratory (CBCRL) has designed a Strata Mechanics Investigation to quantify the effect of pneumatically stowed packs on gateroad stability. In order to make the results comparable with similar installations elsewhere, full account of the geological conditions will be taken and the investigation will include the assessment of past gateroad performance and computer modelling of the investigation sites.

This report presents a summary of the investigation package, individual aspects of which will be described in further reports as they are undertaken.

INVESTIGATION DESIGN

The investigation design was chosen to fulfill the following requirements:

a) to provide enough information to allow an accurate assessment of the effectiveness of pneumatically stowed packs,

b) to enable the investigation results to be compared effectively with results from other investigations in different geological conditions,

c) to provide a basis for further strata mechanics investigations in the coalfield,

d) to assist the development of computer models as an aid to coal mine planning.

This is accomplished by including four concurrent stages in the investigation package, each of which is described below.

MONITORING OF INSTRUMENTED GATEROAD SITES

Current planning involves the installation of two different pneumatic stowing systems in nearby gateroads. The first of these systems is due to be installed in the return gate of the 4W District (Fig. 1). The updip panel, 3W, is mined using hand filled packs.

Two sites will be installed, one in each return gate, the site in 3W acting as a control. Site locations will be chosen to avoid the effects of barrier pillar protection, abnormal geologies and atypical mining conditions. Subsequent sites may be installed later to confirm original results or to investigate the effects of the features mentioned above.

Whilst individual instrumenmtation sites might differ slightly, the general instrumentation, installation and monitoring package outlined below will be followed.

Instrumentation

The parameters to be monitored and the corresponding instruments to be used are as follows:

- Differential strata movement around the gateroad	Point anchored Strata bolts
- Convergence and roadway profile deformation	Strata bolts/tape and offset
- Pack closure	Pack struts
- Pack stress	Flat Jacks/pack dynamometers

Point anchored strata bolts - Standard strata bolts, cut or extended to the desired length, are installed around the gateroad in the roof, sides and floor. The bolts are anchored by quick setting resin or mechanical means at the distal end, the movement at this point being represented by the movement of the free end.

By survey levelling from the bolts to a reference station in a more stable area of the roadway, differential strata movement and the relative contributions of floor heave and roof lowering can be calculated. Short strata bolts or stations on the arch itself will be used to determine arch deformation as well as a simple tape and offset determination of the arch profile.

Pack Struts - Measurement of convergence in the pack must be determined by an instrument capable of being read from the gateroad and, since they are rarely recovered, such instruments must be simple, inexpensive and reliable.

The Pack Strut is of telescopic tubular steel construction connected to the roadway by a series of threaded pipes joined by sleeves. From the top member of the strut (Fig. 2), a flexible cable runs to the roadway through determination of convergence provided by the difference between successive measurements of the distance between the knot and the access tube.

Pack Dynamometers and Flat Jacks - The Pack Dynamometer is a robust, simple and relatively inexpensive device for measuring pack loads. It consists of an oil-filled chamber connected to a calibrated pressure gauge by an armored flexible tube (Fig. 3).

A Flat Jack consists of a plate-like cell filled with oil or mercury and connected to a pressure transducer. Oil is delivered from a pump unit to the transducer, and when the cell pressure and pump pressure are equal, the transducer valve opens and the oil returns to the pump (Fig. 4).

Installation

Instrumentation described above will be installed to the pattern shown in Fig. 5.

Strata bolts will be installed at the brushing face either between production shifts or over a weekend. Pack instrumentation will be installed in the pack adjacent to the bolt section during the following week.

Monitoring

Investigation sites will be monitored at a frequency governed by the proximity of the face, i.e., as the faceline advances further from the site, monitoring frequency will decrease. In addition to monitoring, some instrumentation maintenance and/or rehabilitation may be necessary depending on the degree of deformation of the roadway.

GEOTECHNICAL EVALUATION OF THE PROXIMATE STRATA

It is particularly important that such an evaluation is included in this investigation as there is very little information of this type available for the Sydney coalfield.

A separate geotechnical evaluation will be carried out for each investigation site installed, in the following stages:

1) Diamond drilling of NX diameter (54 mm) cored boreholes to 15 m above and below the seam.
2) Logging of the cores on the basis of lithology, integrity, parting frequency, joint frequency, etc., and the allocation of specimens for testing.
3) Testing of specimens to obtain physical and mechanical properties data.
4) Geotechnical mapping of the mine opening.

BACK ANALYSIS

In order to provide more data for the comparison of pneumatically stowed and traditionally stowed gateroads, it will be necessary to carry out simple measurements in as many other currents and abandoned gateroads as possible.

The method entails the determination of the roadway profile at varying distances behind the coal face. The resulting data is then plotted on a roadway plan and section, which when combined with other production data (e.g., face advance rates, face stand locations, roadway rips and dints, changes in pillar widths) allows the gross effects of these factors on roadway deformation to be determined.

The information required (an accurate gateroad profile obtained by tape and offset or by photographic methods) is well within the scope and ability of any colliery ventilation or survey department and the results give excellent indications of roadway trends.

COMPUTER MODELLING

Recent advances in computer design have allowed much more complex programs to be run at greater speeds. This trend will eventually allow large,detailed mathematical models of mine structures to be analyzed and used with a larger degree of confidence than can currently be claimed.

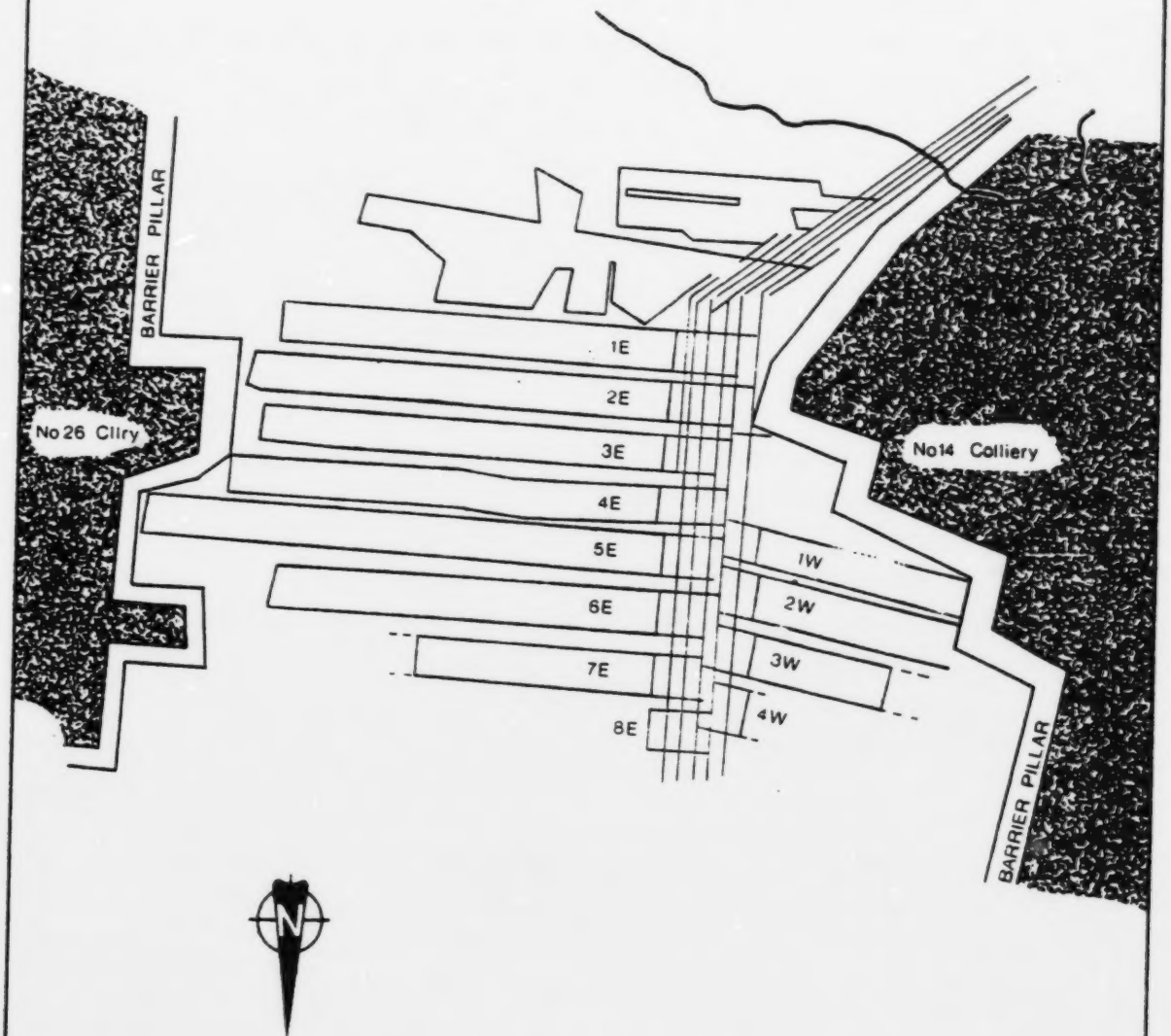
In order to make the best use of currently available models to direct research workers to further improvements, it is important that information gathered during this investigation be used in the computer simulation of pneumatically stowed gateroad.

The choice of modelling system and the source of the program will be made when sufficient data has been collected (particularly the geotechnical evaluation and preliminary convergence data) and the accuracy of the model will be checked against in situ behaviour.

DISCUSSION

It is felt that the investigation design outlined above represents the minimum required to evaluate properly the performance of a pneumatically stowed gateroad. It will, however, require considerable cooperation between CBDC and CBCRL personnel to carry out. In particular, CBDC assistance will be required in the drilling of cored and instrument holes, core logging and routine monitoring.

While it is well recognized that such an investigation will upset and occasionally retard normal face end operations, it is only through such investigations that a technical assessment can be made of coal pillar necessity and dual-life gateroad feasibility.



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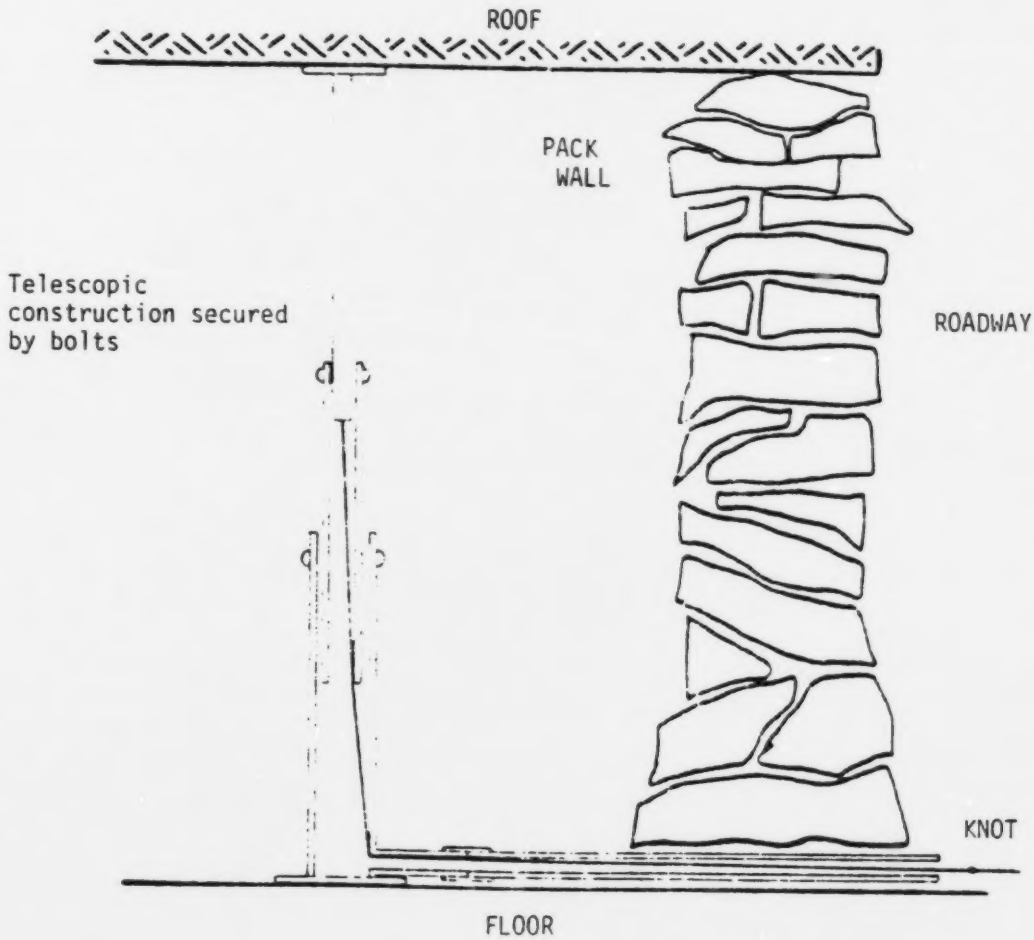

As closure causes telescoping of the strut, the distance measured from the knot to the end of the pipe increases, hence convergence can be calculated.

CAPE BRETON COAL RESEARCH LABORATORY		Energy, Mines and Resources Canada
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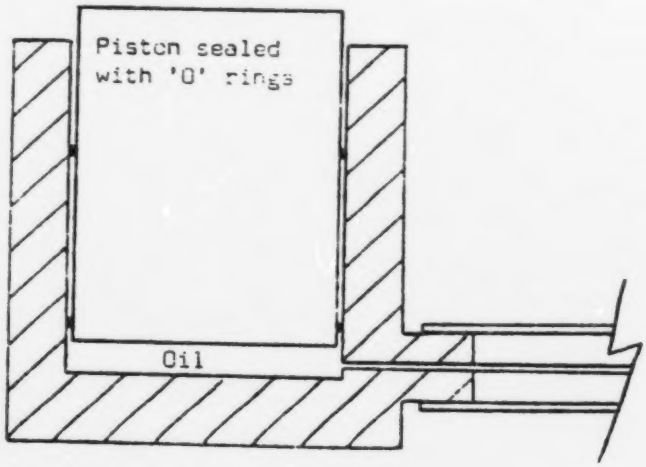
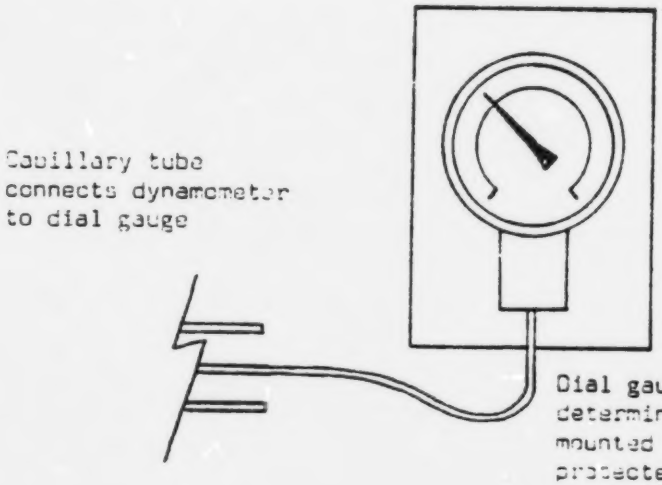
		file NO 82-13/2





CAPE BRETON COAL RESEARCH LABORATORY		Energy, Mines and Resources Canada
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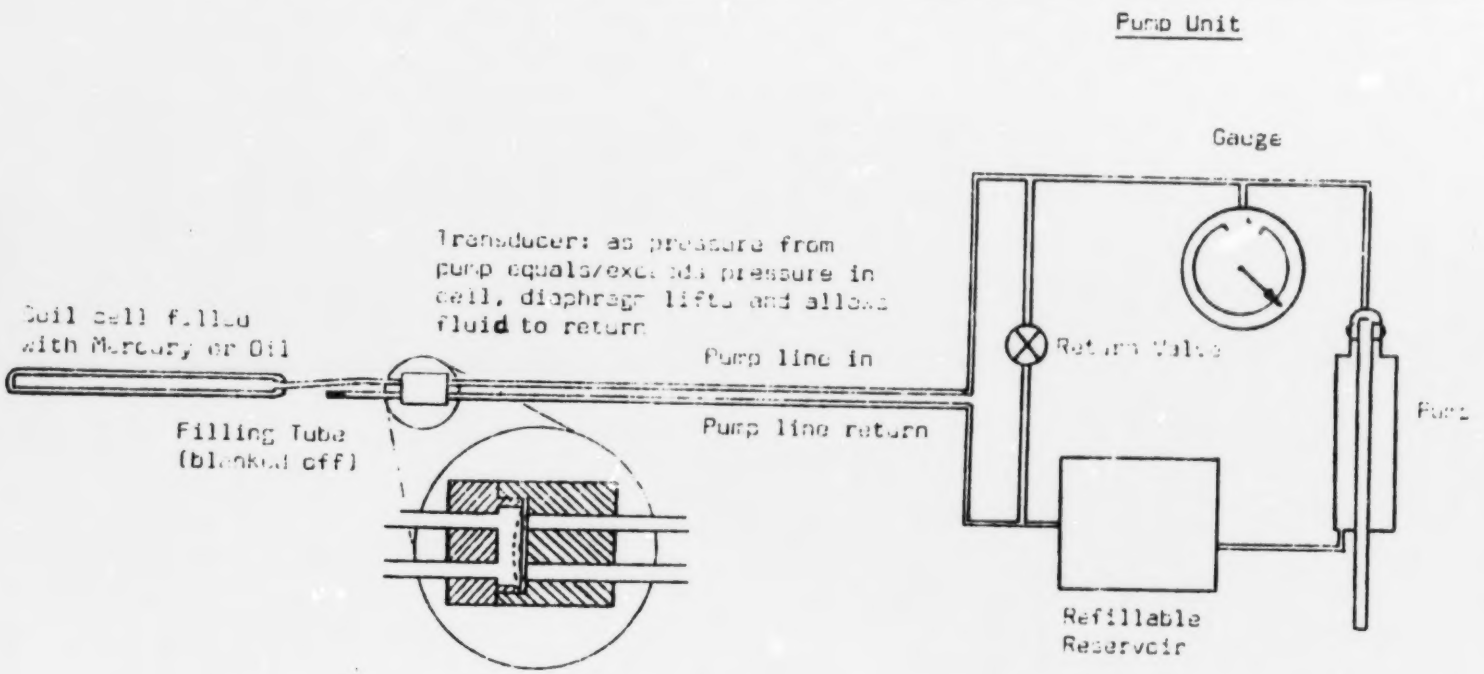
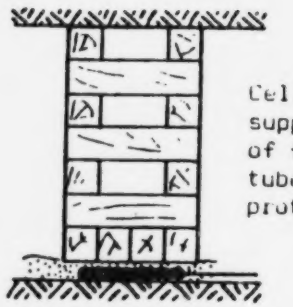
		file NO 82-13/3


Pump Unit
Gauge
Transducer: as pressure from pump equals/exceeds pressure in cell, diaphragm lifts and allows fluid to return
Soil cell filled with Mercury or Oil
Pump line in
Return Valve
Filling Tube (blanked off)
Pump line return
Refillable Reservoir



Cell in position below support element in bed of fine coal. Plastic tubes to transducer protected by conduit

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TITLE	Fig. 4	drawn
The soil instruments flat jack.		checked TRCh
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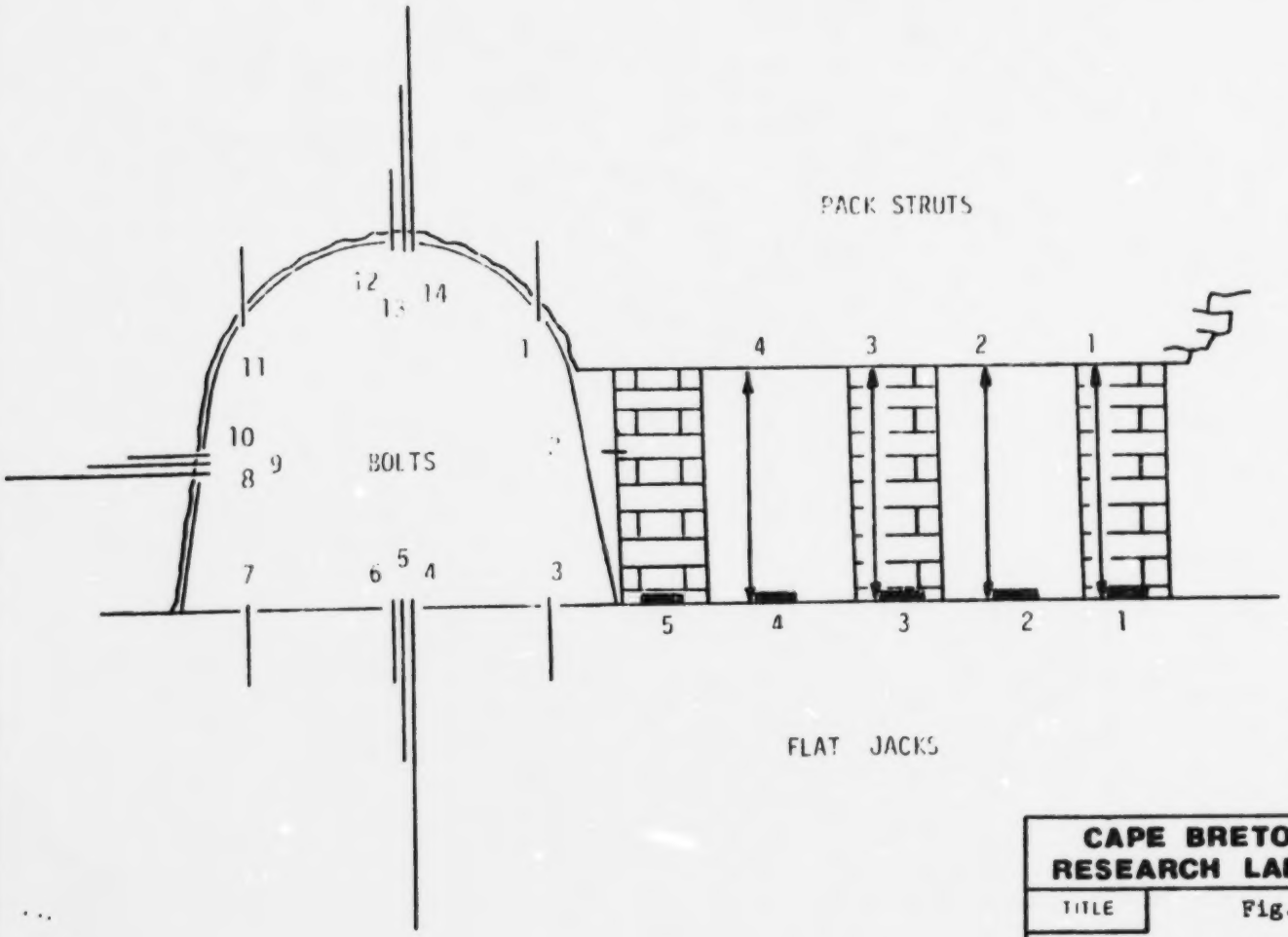

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TITLE	Fig. 5	drawn R.
Instrumentation installation pattern.		checked TRCA
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